Source: https://www.epa.gov/pfas/our-current-understanding-human-health-and-environmental-risks-pfas

Our Current Understanding of the Human Health and Environmental Risks of PFAS
Per- and Polyfluoroalkyl Substances (PFAS) Are a Group of Manufactured Chemicals

PFAS are a group of manufactured chemicals that have been used in industry and consumer products since the 1940s because of their useful properties. There are thousands of different

PFAS, some of which have been more widely used and studied than others.

Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS), for example, are two of the most widely used and studied chemicals in the PFAS group. PFOA and PFOS have been replaced in the United States with other PFAS in recent years.

One common characteristic of concern of PFAS is that many break down very slowly and can build up in people, animals, and the environment over time.

PFAS Can Be Found in Many Places

PFAS can be present in our water, soil, air, and food as well as in materials found in our homes or workplaces, including:

- **Drinking water** – in public drinking water systems and private drinking water wells.
- **Soil and water at or near waste sites** - at landfills, disposal sites, and hazardous waste sites such as those that fall under the federal Superfund and Resource Conservation and Recovery Act programs.
- **Fire extinguishing foam** - in aqueous film-forming foams (or AFFFs) used to extinguish flammable liquid-based fires. Such foams are used in training and emergency response events at airports, shipyards, military bases, firefighting training facilities, chemical plants, and refineries.
- **Manufacturing or chemical production facilities that produce or use PFAS** – for example at chrome plating, electronics, and certain textile and paper manufacturers.
- **Food** – for example in fish caught from water contaminated by PFAS and dairy products from livestock exposed to PFAS.
- **Food packaging** – for example in grease-resistant paper, fast food containers/wrappers, microwave popcorn bags, pizza boxes, and candy wrappers.
- **Household products and dust** – for example in stain and water-repellent used on carpets, upholstery, clothing, and other fabrics; cleaning products; non-stick cookware; paints, varnishes, and sealants.
- **Personal care products** – for example in certain shampoo, dental floss, and cosmetics.
- **Biosolids** – for example fertilizer from wastewater treatment plants that is used on agricultural lands can affect ground and surface water and animals that graze on the land.

People Can Be Exposed to PFAS in a Variety of Ways
Due to their widespread production and use, as well as their ability to move and persist in the environment, surveys conducted by the Centers for Disease Control and Prevention (CDC) show

that most people in the United States have been exposed to some PFAS. Most known exposures are relatively low, but some can be high, particularly when people are exposed to a concentrated source over long periods of time. Some PFAS chemicals can accumulate in the body over time.

Current research has shown that people can be exposed to PFAS by:

- Working in occupations such as firefighting or chemicals manufacturing and processing.
- Drinking water contaminated with PFAS.
- Eating certain foods that may contain PFAS, including fish.
- Swallowing contaminated soil or dust.
- Breathing air containing PFAS.
- Using products made with PFAS or that are packaged in materials containing PFAS.

Exposure to PFAS May be Harmful to Human Health

Current scientific research suggests that exposure to certain PFAS may lead to adverse health outcomes. However, research is still ongoing to determine how different levels of exposure to different PFAS can lead to a variety of health effects. Research is also underway to better understand the health effects associated with low levels of exposure to PFAS over long periods of time, especially in children.

What We Know about Health Effects

Current peer-reviewed scientific studies have shown that exposure to certain levels of PFAS may lead to:

- Reproductive effects such as decreased fertility or increased high blood pressure in pregnant women.
- Developmental effects or delays in children, including low birth weight, accelerated puberty, bone variations, or behavioral changes.
- Increased risk of some cancers, including prostate, kidney, and testicular cancers.
- Reduced ability of the body's immune system to fight infections, including reduced vaccine response.
- Interference with the body's natural hormones.
- Increased cholesterol levels and/or risk of obesity.

Additional Health Effects are Difficult to Determine

Scientists at EPA, in other federal agencies, and in academia and industry are continuing to conduct and review the growing body of research about PFAS. However, health effects associated with exposure to PFAS are difficult to specify for many reasons, such as:

- There are thousands of PFAS with potentially varying effects and toxicity levels, yet most studies focus on a limited number of better known PFAS compounds.
- People can be exposed to PFAS in different ways and at different stages of their life.
- The types and uses of PFAS change over time, which makes it challenging to track and assess how exposure to these chemicals occurs and how they will affect human health.

Certain Adults and Children May Have Higher Exposure to PFAS

Adults

Some people have higher exposures to PFAS than others because of their occupations or where they live. For example:

- Industrial workers who are involved in making or processing PFAS or PFAS-containing materials, or people who live or recreate near PFAS-producing facilities, may have greater exposure to PFAS.
- Pregnant and lactating women tend to drink more water per pound of body weight than the average person and as a result they may have higher PFAS exposure compared to other people if it is present in their drinking water.

Children

Because children are still developing, they may be more sensitive to the harmful effects of chemicals such as PFAS. They can also be exposed more than adults because:

- Children drink more water, eat more food, and breathe more air per pound of body weight than adults, which can increase their exposure to PFAS.
- Young children crawl on floors and put things in their mouths which leads to a higher risk of exposure to PFAS in carpets, household dust, toys, and cleaning products.

Breast milk from mothers with PFAS in their blood and formula made with water containing PFAS can expose infants to PFAS, and it may also be possible for children to be exposed in utero during pregnancy. Scientists continue to do research in this area. Based on current science, the benefits of breastfeeding appear to outweigh the risks for infants exposed to PFAS in breast milk. To weigh the risks and benefits of breastfeeding, mothers should contact their doctors.

Source: https://www.pca.state.mn.us/news-and-stories/groundbreaking-study-shows-unaffordable-costs-of-pfas-cleanup-from-wastewater

Groundbreaking study shows unaffordable costs of PFAS cleanup from wastewater

Findings underscore need to reduce use of "forever chemicals"

This example of a large water filtration facility in New Brighton, MN, for TCE contamination, would be needed for PFAS removal from wastewater for a community of about 5,000 people.

A new report published by the Minnesota Pollution Control Agency (MPCA) finds that technologies and expenses needed to remove and destroy per- and polyfluoroalkyl substances (PFAS) from certain wastewater streams across Minnesota would cost between $14 and $28 billion over 20 years. The study is the first of its kind and, although specific to Minnesota, the novel methods developed to estimate costs can be applied anywhere.

The MPCA commissioned the independent study as part of Minnesota's PFAS Blueprint, a comprehensive interagency plan to prevent, manage, and clean up PFAS pollution. The report, titled *Evaluation of Current Alternatives and Estimated Cost Curves for PFAS Removal and Destruction from Municipal Wastewater, Biosolids, Landfill Leachate, and Compost Contact Water*, was prepared by Barr Engineering Company and Hazen & Sawyer with funding from the Minnesota Environment and Natural Resources Trust Fund.

"The exorbitant costs associated with removing PFAS from community wastewater systems underscores the need to address PFAS pollution long before it gets into the waste stream," said MPCA Commissioner Katrina Kessler. "At no fault of their own, wastewater treatment facilities receive PFAS from a variety of sources and they cannot carry the burden of cleaning up the pollution. We must all focus on preventing PFAS from entering the environment in the first place."

Unaffordability of PFAS cleanup from wastewater

The full report will be of interest to the wastewater management and scientific communities. Key findings of broader interest include:

- Removing and destroying PFAS from water and biosolids leaving Minnesota's wastewater treatment facilities could cost between $14 billion and $28 billion over 20 years.
- PFAS can be bought for $50 - $1,000 per pound (according to MPCA estimates), but costs between $2.7 million and $18 million per pound to remove and destroy from municipal wastewater, depending on facility size.
- Small wastewater treatment facilities would face per-pound costs over six times greater than large facilities, due to economies of scale.
- New "short-chain" types of PFAS are more difficult and up to 70% more expensive to remove and destroy compared to old "long-chain" PFAS.

Cost estimates are based on the required upgrades to Minnesota's existing wastewater infrastructure to treat and destroy PFAS using current commercially available technologies and

PFAS levels. In total, 13 PFAS removal and destruction technologies passed a screening on their real-world effectiveness and the most cost-effective technology was selected for statewide cost development. Complete details and additional findings are found in the full report.

New technology that reduces costs to remove and destroy PFAS from wastewater is in development, but the MPCA believes that without an alternative source of funding, PFAS removal and destruction from municipal wastewater will be unaffordable for the foreseeable future. In contrast, emerging biosolids technologies capable of destroying PFAS can be cost-competitive with current practices.

PFAS in wastewater

PFAS can enter wastewater through industrial processes, everyday use of commercial products, or when PFAS-containing products are discarded in landfills and compost sites. Even decades after they are brought to a landfill or compost site, PFAS can make their way into liquids called landfill leachate and compost contact water. These liquids are often sent to wastewater treatment facilities that are not designed to remove PFAS and ultimately released into the environment, where PFAS can contaminate surface water, groundwater, drinking water, fish, other wildlife, and the food supply. Targeting PFAS in wastewater streams, as the study assesses, would be a significant step toward protecting these resources.

Minnesota's wastewater treatment facilities recognize the need to address PFAS pollution. They have begun monitoring for PFAS and completing PFAS source identification work, but no municipal wastewater facility has the infrastructure capable of removing and destroying PFAS.

Managing and preventing PFAS pollution

Minnesota's PFAS Blueprint prioritizes pollution prevention as the most effective way to protect health and the environment, and the new PFAS wastewater cleanup cost estimates add a greater urgency to prevention efforts in Minnesota and elsewhere.

The MPCA is working to implement a new law passed by the Minnesota Legislature and signed by Gov. Tim Walz to phase out nonessential PFAS use over the coming decade. The Legislature also funded PFAS Blueprint programs to help businesses transition away from PFAS, protect drinking water supplies, and enhance monitoring systems.

Source: https://www.inogenalliance.com/blog-post/faq-pfas-definition-sources-benefits-and-risks

Where Do PFAS Come From?
In the 1930s, a scientist developed new chemical compounds that would come to be known as PFAS. These compounds don't occur naturally but are made up of chains of carbon-fluorine bonds, one of the strongest bonds in nature. In fact, they are so persistent that they are often called "forever chemicals."

The first commercial application of PFAS was Teflon in the 1940s. Since the 1940s, PFAS have been used in thousands of commercial, industrial, and military applications all over the globe and they continue to be developed.

What Do PFAS Do?
PFAS is an umbrella term that covers thousands of chemicals with similar chemical structures. PFAS have some or all of the following properties:

- Repel oil, water, and other liquids
- Temperature resistance
- Friction reduction
- Stability and durability

PFAS are used in many products and applications including:

- **Food packaging and non-stick cookware**: They repel grease and keep food sealed. Microwave popcorn bags are a good example.
- **Coating and Insulation:** Think electrical wire coatings, mechanical wear reduction for metals, and paints for corrosion prevention.
- **Fire fighting**: Aqueous Film Forming Foam (AFFF) is used to fight hazardous flammable liquid fires.
- **Clothing and textiles**: Including waterproofed outerwear, stain-resistant carpets and textiles, and Personal Protective Equipment (PPE).
- **Manufacturing processes**: for industries such as semiconductor, plastics, composite resins, and more.

PFAS are part of thousands of products and manufacturing processes. Though some PFAS have been phased out, banned, or limited, others continue to be used in new product development globally.

What Are the Health Risks of PFAS?
The short answer is: there's mounting evidence that some PFAS pose health risks but we don't know everything yet. It *is* certain that PFAS enter the bodies of humans and animals in many different ways and then they stay there for a long time. The Agency for Toxic Substances and Disease Registry (ATSDR) highlights the following risks:

A large number of studies have examined possible relationships between levels of per- and polyfluoroalkyl substances (PFAS) in blood and harmful health effects in people. However, not

all of these studies involved the same groups of people, the same type of exposure, or the same PFAS. These different studies therefore reported a variety of health outcomes. Research involving humans suggests that high levels of certain PFAS may lead to the following:

- Increased cholesterol levels
- Decreased vaccine response in children
- Changes in liver enzymes
- Increased risk of high blood pressure or pre-eclampsia in pregnant women
- Small decreases in infant birth weights
- Increased risk of kidney or testicular cancer
- PFAS have been found in human blood in studies worldwide.

Many other scientific and regulatory bodies cite similar risks. The emphasis here is *risk,* not definite cause and effect. We are sure that some PFAS chemicals are harmful, we just haven't nailed down all the specifics yet.

Environmental Risk of PFAS

Environmental risks are just as difficult to determine as human health risks but there are several main concerns:

- PFAS easily get into water supplies and bodies of water but are very difficult to get out.
- PFAS can be taken up by plants and can build up in the bodies of fish and wild animals which could potentially also pose human health risk if consumed.
- PFAS aren't naturally occurring so we just don't know how they interact in natural systems.
- Safe disposal procedures are incredibly expensive and difficult to monitor since PFAS are able to spread quickly and at great distances from the source in so many different ways (e.g. air, water, soil leaching).

As with human health risk, environmental risks are still being assessed but the evidence is mounting that PFAS can be harmful to the environment. PFAS in drinking water continues to be an area of greatest concern.

Source: https://www.inquirer.com/news/pfas-forever-chemicals-drinking-water-vet-astroturf-philadelphia-20230307.html

What to know about 'forever chemicals,' artificial turf, Phillies cancer deaths, and our story

Longtime Philadelphia sports fans remember these names: Tug McGraw. Darren Daulton. John Vukovich. John Oates. Ken Brett. David West.

All six played for the Phillies. And all six died of glioblastoma, an aggressive form of brain cancer. All were younger than 60.

And all played at Veterans Stadium on a field that was considered state-of-the-art, a so-called "magic carpet": artificial turf. But in recent years, environmentalists, scientists and researchers have expressed growing concern that the chemicals in the turf could possibly be linked to some kinds of cancer and other health problems.

What chemicals were in the artificial turf at Veterans Stadium?

Among the chemicals found in AstroTurf are PFAS, or per-and polyfluoroalkyl substances — so-called "forever chemicals," which the EPA has said cause "adverse health effects that can devastate families."

They are found in a host of products, from turf and nonstick cookware to firefighting gear and food packaging. Few of the estimated 12,000 PFAS have been extensively studied.

Why are they called 'forever chemicals?'

They don't break down in the environment. In the case of artificial turf, PFAS can seep into the soil or wash into the water supply. They stay in the human body for years.

How do we know for sure that the turf contained these chemicals?

The Inquirer obtained pieces of the turf that was on the field at Veterans Stadium from 1977 to 1981. Tests run on those samples by Eurofins Lancaster Laboratories Environmental Testing found the turf contained 16 different types of PFAS. Researchers at the University of Notre Dame tested additional samples of the Vet's turf, and also found the chemicals.

Do we know if this caused the Phillies to die of brain cancer?

Experts say that there isn't sufficient data to fully understand the potential risks of inhaling forever chemicals, or coming in repeated contact with them on a playing surface. Thus far, there have been no studies linking forever chemicals to brain cancer.

Recent international studies have found PFAS chemicals in the human brain, including in tumors. The chemicals have been linked to kidney and testicular cancer, decreased fertility and immunity to fight infections, and increased risks of asthma and thyroid disease. The rate of brain cancer among the 532 Phillies who played at the Vet between 1971 and 2003 is about three times

the average rate among adult men. Experts say that could be coincidental, given the small size of the group.

How many stadiums still use artificial turf and how many playing fields in Philadelphia are not real grass?

Just five of Major League Baseball's 30 teams play on artificial turf; 14 of the NFL's 30 stadiums have it. FIFA, professional soccer's governing body, insists on natural grass fields for World Cup matches.

Philadelphia maintains five public turf fields in South, North, and Northeast Philly. An additional six artificial turf fields are managed by the School District of Philadelphia. And the city plans to include a dozen new artificial turf fields as part of its $250 million renovation of FDR Park in South Philly, despite opposition from some residents and environmentalists.

Has artificial turf and other products with PFAS been banned or restricted?

Yes.

Several towns in Massachusetts and California have put in place moratoriums on artificial turf; Massachusetts, Connecticut and Vermont have bills at the state level to ban fake grass. Maine prohibits the sale of rugs, carpets and fabric treatments that contain PFAS. Even chemical giant 3M announced in December it will no longer use PFAS after 2025.

What is the EPA doing about this potential hazard?

Last summer, as a preliminary step, the EPA published drinking water health advisory levels for two of the most widely used PFAS chemicals, PFOS and PFOA.

These levels, when the EPA officially adopts them, will require municipalities to essentially eliminate PFAS from their drinking water. The EPA is expected to make the limits enforceable soon. The agency has also published a multi-year plan to study and address PFAS contamination across the country.

Could others be at risk?

Yes.

These same chemicals lurk in the turnout gear that firefighters wear to protect themselves on the job. Cancer has now emerged as their leading cause of occupational death, making up 75% of active-duty firefighter deaths in 2019.

Drinking water contaminated with PFAS is also hazardous. A former Navy base in Warminster and another in Willow Grove used firefighting foam containing PFAS that has leached into the public water supply. As part of a national study, The Centers for Disease Control and Prevention is examining the human health effects of PFAS on people who live near those two former bases.